5: Rate Design

Retail electricity and natural gas utility rate structures and price levels influence customer consumption, and thus are an important tool for encouraging the adoption of energy-efficient technologies and practices. The rate design process typically involves balancing multiple objectives, among which energy efficiency is often overlooked. Successful rate designs must balance the overall design goals of utilities, customers, regulators, and other stakeholders, including encouraging energy efficiency.

Overview

Retail rate designs with clear and meaningful price signals, coupled with good customer education, can be powerful tools for encouraging energy efficiency. At the same time, rate design is a complex process that must take into account multiple objectives (Bonbright, 1961; Philips, 1988). The main priorities for rate design are recovery of utility revenue requirements and fair apportionment of costs among customers.

Other important regulatory and legislative goals include:

- Stable revenues for the utility.
- Stable rates for customers.
- Social equity in the form of lifeline rates for essential needs of households (PURPA of 1978).
- Simplicity of understanding for customers and ease of implementation for utilities.
- Economic efficiency to promote cost-effective load management.

This chapter considers the additional goal of encouraging investment in energy efficiency. While it is difficult to achieve every goal of rate design completely, consideration of a rate design's impact on adoption of energy efficiency and any necessary trade-offs can be included as part of the ratemaking process.

Using Rate Design to Promote Energy Efficiency

In developing tariffs to encourage energy efficiency, the following questions arise: (1) What are the key rate design issues, and how do they affect rate designs for energy efficiency? (2) What different rate design options are possible, and what are their pros and cons? (3) What other mechanisms can encourage efficiency that are not driven by tariff savings? and (4) What are the most successful strategies for encouraging energy efficiency in different jurisdictions? These questions are addressed throughout this chapter.

Leadership Group Recommendations Applicable to Rate Design

- Modify ratemaking practices to promote energy efficiency investments.
- Broadly communicate the benefits of, and opportunities for, energy efficiency.

A more detailed list of options specific to the objective of promoting energy efficiency in rate design is provided at the end of this chapter.

Background: Revenues and Rates

Utility rates are designed to collect a specific revenue requirement based on natural gas or electricity sales. As rates are driven by sales and revenue requirements, these three aspects of regulation are tightly linked. (Revenue requirement issues are discussed in Chapter 2: Utility Ratemaking & Revenue Requirements.)

Until the 1970s, rate structures were based on the principle of average-cost pricing in which customer prices reflected the average costs to utilities of serving their customer class. Because so many of a utility's costs were fixed, the main goal of rate design up until the 1970s was to promote sales. Higher sales allowed fixed costs to be spread over a larger base and helped push rates down, keeping stakeholders content with average-cost based rates (Hyman et al., 2000).

This dynamic began to change in many jurisdictions in the 1970s, with rising oil prices and increased emphasis on conservation. With the passage of the 1978 Public Utility Regulatory Policies Act (PURPA), declining block rates were replaced by flat rates or even inverted block rates, as utilities began to look for ways to defer new plant investment and reduce the environmental impact of energy consumption.

Key Rate Design Issues

Utilities and regulators must balance competing goals in designing rates. Achieving this balance is essential for obtaining regulatory and customer acceptance. The main rate design issues are described below.

Provide Recovery of Revenue Requirements and Stable Utility Revenues

A primary function of rates is to let utilities collect their revenue requirements. Utilities often favor rate forms that maximize stable revenues, such as declining block rates. The declining block rate has two or more tiers of usage, with the highest rates in the first tier. Tier 1 is typically a relatively low monthly usage level that most customers exceed. This rate gives utilities a high degree of certainty regarding the number of kilowatt-hours (kWh) or therms that will be billed in Tier 1. By designing Tier 1 rates to collect the utility's fixed costs, the utility gains stability in the collection of those costs. At the same time, the lower Tier 2 rates encourage higher energy consumption rather than efficiency, which is detrimental to energy efficiency impacts.[1] Because energy efficiency measures are most likely to change customer usage in Tier 2, customers will see smaller bill reductions under declining block rates than under flat rates. Although many utilities have phased out declining block rates, a number of utilities continue to offer them.[2]

Another rate element that provides revenue stability but also detracts from the incentive to improve efficiency is collecting a portion of the revenue requirement through a customer charge that is independent of usage. Because the majority of utility costs do not vary with changes in customer usage level in the short run, the customer charge also has a strong theoretical basis. This approach has mixed benefits for energy efficiency. On one hand, a larger customer charge means a smaller volumetric charge (per kWh or therm), which lowers the customer incentive for energy efficiency. On the other hand, a larger customer charge and lower volumetric charge reduces the utilities profit from increased sales, reducing the utility disincentive to promote energy efficiency.

Rate forms like declining block rates and customer charges promote revenue stability for the utility, but they create a barrier to customer adoption of energy efficiency because they reduce the savings that customers can realize from reducing usage. In turn, electricity demand is more likely to increase, which could lead to long-term higher rates and bills where new supply is more costly than energy efficiency. To promote energy efficiency, a key challenge is to provide a

1 Brown and Sibley (1986) opine that a declining block structure can promote economic efficiency if the lowest tier rate can be set above marginal cost, while inducing additional consumption by some consumers. A rising marginal cost environment suggests, however, that a declining block rate structure with rates below the increasing marginal costs is economically inefficient.

2 A partial list of utilities with declining block residential rates includes: Dominion Virginia Power, VA; Appalachian Power Co, VA; Indianapolis Power and Light Co., IN; Kentucky Power Co., KY; Cleveland Electric Illum Co., OH; Toledo Edison Co., OH; Rappahannock Electric Coop, VA; Lincoln Electric System, NE; Cuivre River Electric Coop Inc., MO; Otter Tail Power Co., ND; Wheeling Power Co., WV; Matanuska Electric Assn Inc., AK; Homer Electric Association Inc., AK; Lower Valley Energy, NE.

level of certainty to utilities for revenue collection without dampening customer incentive to use energy more efficiently.

Fairly Apportion Costs Among Customers

Revenue allocation is the process that determines the share of the utility's total revenue requirement that will be recovered from each customer class. In regulatory proceedings, this process is often contentious, as each customer class seeks to pay less. This process makes it difficult for utilities to propose rate designs that shift revenues between different customer classes.

In redesigning rates to encourage energy efficiency, it is important to avoid unnecessarily or inadvertently shifting costs between customer classes. Rate design changes should instead focus on providing a good price signal for customer consumption decisions.

Promote Economic Efficiency for Cost-Effective Load Management

According to economic theory, the most efficient outcome occurs when prices are equal to marginal costs, resulting in the maximum societal net benefit from consumption.

Marginal Costs

Marginal costs are the *changes* in costs required to produce one additional unit of energy. In a period of rising marginal costs, rates based on marginal costs more realistically reflect the cost of serving different customers, and provide an incentive for more efficient use of resources (Bonbright, 1961; Kahn, 1970; Huntington, 1975; Joskow, 1976; Joskow, 1979).

A utility's marginal costs often include its costs of complying with local, state, and federal regulations (e.g., Clean Air Act), as well as any utility commission policies addressing the environment (e.g., the use of the societal test for benefit-cost assessments). Rate design based on the utility's marginal costs that promotes cost-effective energy efficiency will further increase environmental protection by reducing energy consumption.

Despite its theoretical attraction, there are significant barriers to fully implementing marginal-cost pricing in electricity, especially at the retail level. In contrast to other commodities, the necessity for generation to match load at all times means that outputs and production costs are constantly changing, and conveying these costs as real time "price signals" to customers, especially residential customers, can be complicated and add additional costs. Currently, about half of the nation's electricity customers are served by organized real-time electricity markets, which can help provide time-varying prices to customers by regional or local area.

Notwithstanding the recent price volatility, exacerbated by the 2005 hurricane season and current market conditions, wholesale natural gas prices are generally more stable than wholesale electricity prices, largely because of the ability to store natural gas. As a result, marginal costs have been historically a less important issue for natural gas pricing.

Short-Run Versus Long-Run Price Signals

There is a fundamental conflict between whether electricity and natural gas prices should reflect short-run or long-run marginal costs. In simple terms, short-run costs reflect the variable cost of production and delivery, while long-run costs also include the cost of capital expansion. For programs such as real-time pricing in electricity, short-run marginal costs are used for the price signals so they can induce efficient operating decisions on a daily or hourly basis.

Rates that reflect long-run marginal costs will promote economically efficient investment decisions in energy efficiency, because the long-run perspective is consistent with the long expected useful lives of most energy efficiency measures, and the potential for energy efficiency to defer costly capital investments. For demand-response and other programs intended to alter consumption on a daily or hourly basis, however, rates based on short-run

Applicability of Rate Design Issues

Implications for Clean Distributed Generation and Demand Response. The rate issues for energy efficiency also apply to clean distributed generation and demand response, with two exceptions. Demand response is focused on reductions in usage that occur for only a limited number of hours in a year, and occur at times that are not known far in advance (typically no more than one day notice, and often no more than a few hours notice). Because of the limited hours of operation, the revenue erosion from demand response is small compared to an energy efficiency measure. In addition, it could be argued that short-run, rather than long-run, costs are the appropriate cost metric to use in valuing and pricing demand response programs.

Public Versus Private Utilities. The rate issues are essentially the same for both public and private utilities. Revenue stability might be a lesser concern for public utilities, as they could approach their city leaders for rate changes. Frequent visits to council chambers for rate changes might be frowned upon, however, so revenue stability will likely remain important to many public utilities as well.

Gas Versus Electric. As discussed above, gas marginal costs are less volatile than electricity marginal costs, so providing prices that reflect marginal costs is generally less of a concern for the gas utilities. In addition, the nature of gas service does not lend itself to complicated rate forms such as those seen for some electricity customers. Nevertheless, gas utilities could implement increasing tier block rates, and/or seasonally differentiated rates to stimulate energy efficiency.

Restructured Versus Non-Restructured Markets. Restructuring has had a substantial impact on the funding, administration, and valuation of energy efficiency programs. It is no coincidence that areas with high retail electricity rates have been more apt to restructure their electricity markets. The higher rates increase the appeal of energy efficiency measures, and the entry of third-party energy service companies can increase customer interest and education regarding energy efficiency options. In a retail competition environment, however, there might be relatively little ratemaking flexibility. In several states, restructuring has created transmission and distribution-only utilities, so the regulator's ability to affect full electricity rates might be limited to distribution costs and rates for default service customers.

marginal cost might be more appropriate. Therefore, in developing retail rates, the goals of short-run and long-run marginal based pricing must be balanced.

Cost Causation

Using long-run marginal costs to design an energy-efficiency enhancing tariff can present another challenge—potential inconsistency with the cost-causation principle that a tariff should reflect the utility's various costs of serving a customer. This potential inconsistency diminishes in the long run, however, because over the long run, some costs that might be considered fixed in the near term (e.g., generation or transmission capacity, new interstate pipeline capacity or storage) are actually variable. Such costs can be reduced through sustained load reductions provided by energy efficiency investment, induced by appropriately designed marginal cost-based rates. Some costs of a utility do not vary with a customer's kWh usage (e.g., hookup and local distribution). As a result, a marginal cost-based rate design may necessarily include some fixed costs, which can be collected via a volumetric adder or a relatively small customer charge. However, utilities that set usage rates near long-run marginal costs will encourage energy efficiency and promote other social policy goals such as affordability for low-income and low-use customers whose bills might increase with larger, fixed charges. Hence, a practical implementation of marginal-cost based ratemaking should balance the trade-offs and competing goals of rate design.

Provide Stable Rates and Protect Low-Income Customers

Rate designs to promote energy efficiency must consider whether or not the change will lead to bill increases. Mitigating large bill increases for individual customers is a fundamental goal of rate design, and in some jurisdictions low-income customers are also afforded particular attention to ensure that they are not adversely affected by rate changes. In some cases, low-income customers are eligible for special rates or rate riders that protect them from large rate increases, as exemplified by the lifeline rates provision in Section 114 of the 1978 PURPA. Strategies to manage bill impacts include phasing-in rate changes to reduce the rate shock in any single year, creating exemptions for certain at-risk customer groups, and disaggregating customers into small customer groups to allow more targeted rate forms.

Because of the concern over bill impacts, new and innovative rates are often offered as voluntary rates. While improving acceptance, voluntary rate structures generally attract a relatively small percentage of customers (less than 20 percent) unless marketed heavily by the utility. Voluntary rates can lead to some "free riders," meaning customers who achieve bill reductions without changing their consumption behavior and providing any real savings to the utility. Rates to promote energy efficiency can be offered as voluntary, but the low participation and free rider issues should be taken into account in their design to ensure that the benefits of the consumption changes they encourage are at least as great as the resulting bill decreases.

Maintain Rate Simplicity

Economists and public policy analysts can become enamored with efficient pricing schemes, but customers generally prefer simple rate forms. The challenge for promoting energy efficiency is balancing the desire for rates that provide the right signals to customers with the need to have rates that customers can understand, and to which they can respond. Rate designs that are too complicated for customers to understand will not be effective at promoting efficient consumption decisions. Particularly in the residential sector, customers might pay more attention to the total bill than to the underlying rate design.

Addressing the Issues: Alternative Approaches

The prior sections listed the issues that stakeholders must balance in designing new rates. This section presents some traditional and non-traditional rate designs and discusses their merits for promoting energy efficiency. The alternatives described below vary by metering/billing requirement, information complexity, and ability to reflect marginal cost.[3]

Rate Design Options

Inclining Tier Block

Inclining tier block rates, also referred to as inverted block rates, have per-unit prices that increase for each successive block of energy consumed. Inclining tiered rates offer the advantages of being simple to understand and simple to meter and bill. Inclining rates can also meet the policy goal of protecting small users, which often include low-income customers. In fact, it was the desire to protect small users that prompted the initiation of increasing tiers in California. Termed "lifeline rates" at the time, the intention was to provide a small base level of electricity to all residential customers at a low rate, and charge the higher rate only to usage above that base level. The concept of lifeline rates continues in various forms for numerous services such as water and sewer services, and can be considered for delivery or commodity rates for electricity and natural gas. However, in many parts of the country, low-income customers are not necessarily low-usage customers, so a lifeline rate might not protect all low-income customers from energy bills.

[3] As part of its business model, a utility may use innovative rate options for the purpose of product differentiation. For example, advanced metering that enables a design with continuously time-varying rates can apply to an end-use (e.g., air conditioning) that is the main contributor to the utility's system peak. Another example is the bundling of sale of electricity and consumer devices (e.g., a 10-year contract for a central air conditioner whose price includes operation cost).

Tiered rates also provide a good fit for regions where the long-run marginal cost of energy exceeds the current average cost of energy. For example, regions with extensive hydroelectric resources might have low average costs, but their marginal cost might be set by much higher fossil plant costs or market prices (for purchase or export).

See Table 5-1 for additional utilities that offer inclining tier residential rates.

Time of Use (TOU)

TOU rates establish varying charges by season or time of day. Their designs can range from simple on- and off-peak rates that are constant year-round to more complicated rates with seasonally differentiated prices for several time-of-day periods (e.g., on-, mid- and off-peak). TOU rates have support from many utilities because of the flexibility to reflect marginal costs by time of delivery.

TOU rates are commonly offered as voluntary rates for residential electric customers,[4] and as mandatory rates for larger commercial and industrial customers. Part of the reason for TOU rates being applied primarily to larger users is the additional cost of TOU metering and billing, as well as the assumed greater ability of larger customers to shift their loads.

TOU rates are less applicable to gas rates, because the natural storage capability of gas mains allows gas utilities to procure supplies on a daily, rather than hourly, basis. Additionally, seasonal variations are captured to a large extent in costs for gas procurement, which are typically passed through to the customer. An area with constrained seasonal gas transportation capacity, however, could merit a higher distribution cost during the constrained season. Alternatively, a utility could recover a higher share of its fixed costs during the high demand season, because seasonal peak demand drives the sizing of the mains.

As TOU rates are typically designed to be revenue-neutral with the status quo rates, a high on-peak price will be accompanied by a low off-peak price. Numerous studies in electricity have shown that while the high on-peak prices do cause a reduction in usage during that period, the low off-peak prices lead to an increase in usage in the low-cost period. There has also been an

Table 5-1. Partial List of Utilities With Inclining Tier Residential Rates

Utility Name	State	Tariff URL
Florida Power and Light	FL	http://www.fpl.com/access/contents/how_to_read_your_bill.shtml
Consolidated Edison	NY	http://www.coned.com/documents/elec/201-210.pdf
Pacific Gas & Electric	CA	http://www.pge.com/res/financial_assistance/medical_baseline_life_support/understanding/index.html#topic4
Southern California Edison	CA	http://www.sce.com/NR/rdonlyres/728FFC8C-91FD-4917-909B-
Arizona Public Service Co	AZ	https://www.aps.com/my_account/RateComparer.html
Sacramento Municipal Util Dist	CA	http://www.smud.org/residential/rates.html
Indiana Michigan Power Co	MI	https://www.indianamichiganpower.com/global/utilities/tariffs/Michigan/MISTD1-31-06.pdf
Modesto Irrigation District	CA	http://www.mid.org/services/tariffs/rates/ums-d-residential.pdf
Turlock Irrigation District	CA	http://www.tid.org/Publisher_PDFs/DE.pdf
Granite State Electric Co	NH	http://www.nationalgridus.com/granitestate/home/rates/4_d.asp
Vermont Electric Cooperative, Inc	VT	http://www.vtcoop.com/PageViewer.aspx?PageName=Rates%20Summary
City of Boulder	NV	http://www.bcnv.org/utilities.html#electric,waterandsewer

[4] For a survey of optional rates with voluntary participation, see Horowitz and Woo (2006).

"income effect" observed where people buy more energy as their overall bill goes down, due to switching consumption to lower price periods. The net effect might not be a significant decrease in total electricity usage, but TOU rates do encourage reduced usage when that reduction is the most valuable. Another important consideration with TOU prices is the environmental impact. Depending on generation mix and the diurnal emissions profile of the region, shifting consumption from the on-peak period to off-peak period might provide environmental net benefits.

The Energy Policy Act of 2005 Section 1252 requires states and non-regulated utilities, by August 8, 2007, to consider adopting a standard requiring electric utilities to offer all of their customers a time-based rate schedule such as time-of-use pricing, critical peak pricing, real-time pricing, or peak load reduction credits.

Dynamic Rates

Under a dynamic rate structure, the utility has the ability to change the cost or availability of power with limited, or no, notice. Common forms of dynamic rates include the following:

- Real-time pricing (RTP) rates vary continuously over time in a way that directly reflects the wholesale price of electricity.

- Critical peak pricing (CPP) rates have higher rates during periods designated as critical peak periods by the utility. Unlike TOU blocks, the days in which critical peaks occur are not designated in the tariff, but are designated on relatively short notice for a limited number of days during the year.

- Non-firm rates typically follow the pricing form of the otherwise applicable rates, but offer discounts or incentive payments for customers to curtail usage during times of system need (Horowitz and Woo, 2006). Such periods of system need are not designated in advance through the tariff, and the customer might receive little notice before energy supply is interrupted. In some cases, customers may be allowed to "buy through" periods when their supply will be interrupted by paying a higher energy charge (a non-compliance penalty). In those cases, the non-firm rate becomes functionally identical to CPP rates.

Dynamic rates are generally used to: 1) promote load shifting by large, sophisticated users, 2) give large users access to low "surplus energy" prices, or 3) reduce peak loads on the utility system. Therefore, dynamic rates are complementary to energy efficiency, but are more useful for achieving demand response during peak periods than reducing overall energy usage.

Two-Part Rates

Two-part rates refer to designs wherein a base level of customer usage is priced at rates similar to the status quo (Part 1) and deviations from the base level of usage are billed at the alternative rates (Part 2). Two-part rates are common among RTP programs to minimize the free rider problem. By implementing a two-part rate, customers receive the real time price only for their change in usage relative to their base level of usage. Without the two-part rate form, most low load-factor customers on rates with demand charges would see large bill reductions for moving to an RTP rate.

A two-part rate form, however, could also be combined with other rate forms that are more conducive to energy efficiency program adoption. For example, a two-part rate could be structured like an increasing tiered block rate, with the Tier 1 allowance based on the customer's historical usage. This structure would address many of the rate design barriers such as revenue stability. Of course, there would be implementation issues, such as determining what historical period is used to set Part 1, and how often that baseline is updated to reflect changes in usage. Also, new customers would need to be assigned an interim baseline.

Demand Charges

Demand charges bill customers based on their peak usage rather than their total usage during the month. For electricity, demand charges are based on usage during particular TOU periods (e.g., peak demand) or usage during any period in the month (e.g., maximum demand). Demand charges can also use a percentage of the highest demand over the prior year or prior season as a minimum demand level used for billing. For natural gas, demand can be based on the highest monthly usage over the past year or season.

For both gas and electricity, utilities prefer demand charges over volumetric charges because they provide greater revenue certainty, and encourage more consistent asset utilization. In contrast to a demand charge, a customer charge that covers more of a utility's fixed costs reduces profits from increased sales, and the utility disincentive to promote energy efficiency.

For energy efficiency programs, demand charges could help promote reductions in usage for those end uses that cause the customer's peak.[5] In general, however, volumetric rates are more favorable for energy efficiency promotion. Increasing the demand charges would reduce the magnitude of the price signal that could be sent through a volumetric charge.

Mechanisms Where Customer Benefits Are Not Driven by Tariff Savings

The rate design forms discussed above allow customers to benefit from energy efficiency through bill reductions; however, other types of programs provide incentives that are decoupled from the customer's retail rate.

Discount for Efficiency via Conservation Behavior

In some cases, energy efficiency benefits are passed on to customers through mechanisms other than retail rates. For example, in California the "20/20" program was implemented in 2001, giving customers a 20 percent rebate off their summer bills if they could reduce their electricity consumption by 20 percent compared to the summer period the prior year. The program's success was likely due to a combination of aggressive customer education, energy conservation behavior (reducing consumption through limiting usage of appliances and end-uses) and investment in energy efficiency. Pacific Gas & Electric (PG&E) has just implemented a similar program for natural gas, wherein customers can receive a rebate of 20 percent of their last winter's bill if they can reduce natural gas usage by 10 percent this winter season. The 20/20 program was popular and effective. It was easy for customers to understand, and there might be a psychological advantage to a program that gives you a rebate (a received reward), as opposed to one that just allows you to pay less than you otherwise would have (a lessened penalty). Applying this concept might require some adjustments to account for changes in weather or other factors.

Benefit Sharing

There are two types of benefit sharing with customers.[6] Under the first type of shared savings, a developer (utility or third party) installs an energy-saving device. The customer shares the bill savings with the developer until the customer's project load has been paid off. In the second type of shared savings, the utility is typically the developer and installs an energy efficiency or distributed generation device at the customer site. The customer then pays an amount comparable to what the bill would have been without the device or measures installed, less a portion of the savings of the device based on utility avoided costs. This approach decouples the customer benefits from the utility rate, but it can be complicated to determine what the consumption would have been without the device or energy efficiency.

PacifiCorp in Oregon tackled this problem by offering a cash payment of 35 percent of the cost savings for residential weatherization measures, where the cost savings was based on the measure's expected annual kWh savings and a schedule of lifecycle savings per kWh (PacifiCorp, 2002).

[5] Horowitz and Woo (2006) show that demand charges can be used to differentiate service reliability, thus implementing curtailable and interruptible service programs that are useful for meeting system resource adequacy.

[6] Note that benefit sharing is not the same as "shared savings," used in the context of utility incentives for promoting energy efficiency programs.

Table 5-2. Pros and Cons of Rate Design Forms

Program Type	Criteria				
	Avoided Cost Benefits and Utility Incentives	Energy and Peak Reductions	Customer Incentive and Bill Impact	Impact on Non-Participants	Implementation and Transition Issues
Increasing Tier Block (Inverted block) http://www.pge.com/tariffs/pdf/E-1.pdf http://www.sdge.com/tm2/pdf/DR.pdf http://www.sdge.com/tm2/pdf/GR.pdf	**Pro:** Good match when long-run marginal costs are above average costs. **Con:** Might not be the right price signal if long-run marginal costs are below average costs.	**Pro:** Can achieve annual energy reductions. **Con:** Does not encourage reductions in any particular period (unless combined with a time-based rate like TOU).	**Pro:** Provides strong incentive to reduce usage. **Con:** Could result in large bill increases for users that cannot change their usage level, and could encourage more usage by the smaller customers.	**Pro:** If mandatory, little impact on other customer classes. **Con:** Could not be implemented on a voluntary basis because of free rider losses.	**Pro:** Simple to bill with existing meters. **Con:** Could require phased transition to mitigate bill impacts.
Time of Use (TOU) http://www.nationalgridus.com/masselectric/home/rates/4_tou.asp	**Pro:** (1) Low implementation cost; (2) Tracks expected marginal costs. **Con:** Unclear if marginal costs should be short- or long-run.	**Pro:** Can achieve peak load relief. **Con:** Might not achieve substantial energy reductions or produce significant emissions benefits.	**Pro:** Provides customers with more control over their bills than flat rates, and incentive to reduce peak usage. **Con:** If mandatory, could result in large bill increases for users that cannot change their usage pattern.	**Pro:** If mandatory, little average impact, but can be large on some customers. **Con:** If optional, potentially large impact due to free riders, which can be mitigated by a careful design.	**Pro:** Extensive industry experience with TOU rate. **Con:** (1) If mandatory, likely opposed by customers, but not necessarily the utility; (2) If optional, opposed by non-participants and possibly the utility.
Dynamic Rates: Real Time Pricing (RTP) http://www.exeloncorp.com/comed/library/pdfs/advance_copy_tariff_revision6.pdf http://www.southerncompany.com/gulfpower/pricing/gulf_rates.asp?mnuOpco=gulf&mnuType=com&mnuItem=er#rates http://www.nationalgridus.com/niagaramohawk/non_html/rates_psc207.pdf	**Pro:** (1) Tracks day-ahead or day-of short-run marginal cost for economically efficient daily consumption decisions; (2) RTP rates can be set to help allocate capacity in an economically efficient manner during emergencies. **Con:** No long-run price signal for investment decisions.	**Pro:** Can achieve peak load relief. **Con:** (1) Not applicable to gas; (2) Might not achieve substantial annual energy reductions or produce significant emissions benefits.	Same as above.	Same as above.	**Con:** (1) If mandatory, likely opposed by customers and the utility due to complexity and implementation cost; (2) High implementation cost for metering and information system costs.
Dynamic Rates: Critical Peak Pricing (CPP) http://www.southerncompany.com/gulfpower/pricing/pdf/rsvp.pdf http://www.idahopower.com/aboutus/regulatoryinfo/tariffPdf.asp?id=263&.pdf http://www.pge.com/tariffs/pdf/E-3.pdf	**Pro:** (1) Tracks short-run marginal cost shortly before emergency; (2) If the CPP rates are set at correctly predicted marginal cost during emergency, they ration capacity efficiently. **Con:** High implementation cost.	**Pro:** Likely to achieve load relief. **Con:** Unlikely to provide significant annual energy reductions.	Same as above.	**Pro:** Little impact, unless the utility heavily discounts the rate for the non-critical hours.	**Con:** (1) If mandatory, likely opposed by customers and the utility due to high implementation cost; (2) If optional, few would object, unless the implementation cost spills over to other customer classes.

Table 5-2. Pros and Cons of Rate Design Forms *(continued)*

Program Type	Criteria				
	Avoided Cost Benefits and Utility Incentives	Energy and Peak Reductions	Customer Incentive and Bill Impact	Impact on Non-Participants	Implementation and Transition Issues
Dynamic Rates Nonfirm http://www.pacificorp.com/Regulatory_Rule_Schedule/Regulatory_Rule_Schedule2220.pdf	**Pro:** (1) Provides emergency load relief to support system reliability; (2) Implements efficient rationing. **Con:** (1) Does not track costs; (2) Potentially high implementation cost.	**Pro:** (1) Can achieve load reductions to meet system needs; (2) Applicable to both gas and electric service. **Con:** Unlikely to encourage investment in energy efficiency measures.	**Pro:** Bill savings compensate customer for accepting lower reliability.	**Pro:** Little impact, unless the utility offers a curtailable rate discount that exceeds the utility's expected cost savings.	**Pro:** (1) If optional, non-participants would not object unless discount is "excessive"; (2) If mandatory, different levels of reliability (at increasing cost) would need to be offered. **Con:** Complicated notice and monitoring requirements.
Two-Part Rates http://www.aepcustomer.com/tariffs/Michigan/pdf/MISTD4-28-05.pdf:	**Pro:** Allows rate to be set at utility avoided cost. **Con:** Requires establishing customer baseline, which is subject to historical usage, weather, and other factors.	**Pro:** Can be used to encourage or discourage peak usage depending on characteristics of "part two" rate form.	**Pro:** Provides incentives for changes in customer's usage. Therefore, no change in usage results in the same bill.	**Pro:** Non-participants are held harmless.	**Pro:** Complexity can be controlled through design of "part two" rate form. **Con:** (1) Customers might not be accustomed to the concept; (2) Difficult to implement for many smaller customers.
Demand Charges http://www.sce.com/NR/sc3/tm2/pdf/ce30-12.pdf	**Pro:** Reflects the customer's usage of the utility infrastructure. **Con:** Does not consider the duration of the usage (beyond 15 minutes or one hour for electric).	**Pro:** Can achieve load reductions. **Con:** Might not achieve substantial annual reductions.	**Pro:** Provides customers with incentive to reduce peak usage and flatten their usage profile. **Con:** If mandatory, could result in large bill increases for users who cannot change their usage pattern.	**Pro:** If mandatory, little average impact, but can be large on some customers. **Con:** If optional, potentially large impact due to free riders, but this can be mitigated by a careful design.	**Con:** (1) If mandatory, likely opposed by customers and the utility due to high implementation cost; (2) If optional, few would object, unless the implementation cost spills over to other customer classes.
Discount for Efficiency, Benefit Sharing, etc. http://www.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/51362.htm http://www.pacificorp.com/Regulatory_Rule_Schedule/Regulatory_Rule_Schedule7794.pdf	**Pro:** Incentive can be tied directly to avoided costs, without the need to change overall rate design. **Con:** Only a portion of the benefits are reflected in the incentive, as rate savings will still be a factor for most options.	**Pro:** Utilities generally have control over what measures are eligible for an incentive, so the mix of peak and energy savings can be determined during program design. **Con:** Impacts might be smaller than those attainable through mandatory rate programs.	**Pro:** (1) Provides direct incentive for program participation, plus ongoing bill reductions (for most options); (2) Does not require rate changes. **Con:** Existing rate forms might impede adoption because of overly low bill savings.	**Pro:** Reflects the characteristics of the underlying rate form.	**Pro:** Implementation simplified by the ability to keep status quo rates. **Con:** Places burden for action on the energy efficiency implementer, whereas a mandatory rate change could encourage customers to seek out efficiency options.
Energy Efficiency Customer Rebate Programs (e.g., 20/20 program in California) www.sce.com/RebatesandSavings/2020 www.sdge.com/tm2/pdf/20-20-TOU.pdf www.pge.com/tariffs/pdf/EZ-2020.pdf	**Pro:** Can avoid more drastic rationing mechanisms when resources are significantly constrained. **Con:** Customer discounts are not set based on utility cost savings, and therefore these programs might over-reward cutomers who qualify.	**Pro:** (1) Links payment of incentive directly to metered energy savings; (2) Easy to measure and verify. **Con:** Focused on throughput and not capacity savings.	**Pro:** (1) Provides a clear incentive to customers to reduce their energy usage, motivates customers, and gets them thinking about their energy usage; (2) Can provide significant bill savings; (3) Doesn't require customers to sign up for any program and can be offered to everyone.	**Con:** Shifts costs to non-participants to the extent that the rebate exceeds the change in utility cost.	**Pro:** Very successful during periods when public interest is served for short-term resource savings, (e.g. energy crisis.) **Con:** Implementation and effectiveness might be reduced after being in place for several years.

On-Bill Financing

The primary function of on-bill financing is to remove the barrier presented by the high first-time costs of many energy efficiency measures. On-bill financing allows the customer to pay for energy efficiency equipment over time, and fund those payments through bill savings. On-bill financing can also deliver financial benefits to the participants by providing them access to low financing costs offered by the utility. An example of on-bill financing is the "Pay As You Save" (PAYS) program, which provides upfront funding in return for a monthly charge that is always less than the savings.[7]

Pros and Cons of Various Designs

Rate design involves tradeoffs among numerous goals. Table 5-2 summarizes the pros and cons of the various rate design forms from various stakeholder perspectives, considering implementation and transition issues. In most cases, design elements can be combined to mitigate weaknesses of any single design element, so the table should be viewed as a reference and starting point.

Successful Strategies

Rate design is one of a number of factors that contribute to the success of energy efficiency programs. Along with rate design, it is important to educate customers about their rates so they understand the value of energy efficiency investment decisions. Table 5-3 shows examples of four states with successful energy efficiency programs and complementary rate design approaches. Certainly, one would expect higher rates to spur energy efficiency adoption, and that appears to be the case for three of the four example states. However, Washington has an active and cost-effective energy efficiency program, despite an average residential rate far below the national average of 10.3 cents per kWh. (EIA, 2006)

Table 5-3. Conditions That Assist Success

	California	Washington State	Massachusetts	New York
Rate Forms and Cost Structures	Increasing tier block rates for residential (PG&E, SCE, and SDG&E). Increasing block rate for residential gas (SDG&E). http://www.pge.com/tariffs/pdf/E-1.pdf http://www.sce.com/NR/sc3/tm2/pdf/ce12-12.pdf http://www.sdge.com/tm2/pdf/DR.pdf http://www.sdge.com/tm2/pdf/GR.pdf	Increasing tier block rates for residential electric (PacifiCorp). Gas rates are flat volumetric (Puget Sound Electric [PSE]). High export value for electricity, especially in the summer afternoon. http://www.pacificorp.com/Regulatory_Rule_Schedule/Regulatory_Rule_Schedule2205.pdf	Flat electricity rates per kWh with voluntary TOU rates for distribution service (Massachusetts Electric). http://www.nationalgridus.com/masselectric/non_html/rates_tariff.pdf	Increasing tier rates for residential (Consolidated Edison). http://www.coned.com/documents/elec/201-210.pdf
Resource and Load Characteristics	Summer electric peaks. Marginal resources are fossil units. High marginal cost for electricity, especially in the summer afternoon. Import transfer capability can be constrained. Winter gas peaks, although electric generation is flattening the difference. http://www.ethree.com/CPUC/E3_Avoided_Costs_Final.pdf	Winter peaking electric loads, but summer export opportunities. Heavily hydroelectric, so resource availability can vary with precipitation. Gas is winter peaking. http://www.nwcouncil.org/energy/powersupply/outlook.asp http://www.nwcouncil.org/energy/powerplan/plan/Default.htm http://www.pse.com/energyEnvironment/supplyPDFs/II--Summary%20Charts%20and%20Graphs.pdf	Part of Indpendant System Operator New England (ISO-NE), which is summer peaking. http://www.nepool.com/trans/celt/report/2005/2005_celt_report.pdf	High summer energy costs and capacity concerns in the summer for the New York City area. http://www.eia.doe.gov/cneaf/electricity/page/fact_sheets/newyork.html

[7] See http://www.paysamerica.org/.

Table 5-3. Conditions That Assist Success *(continued)*

	California	Washington State	Massachusetts	New York
Average Residential Electric Rates	13.7 cents/kWh (EIA, 2006)	6.7 cents/kWh (EIA, 2006)	17.6 cents/kWh (EIA, 2006)	15.7 cents/kWh (EIA, 2006)
Market and Utility Structure	Competitive electric generation and gas procurement. Regulated wires and pipes. http://www.energy.ca.gov/electricity/divestiture.html http://www.cpuc.ca.gov/static/energy/electric/ab57_briefing_assembly_may_10.pdf	Vertically integrated. http://www.wutc.wa.gov/webimage.nsf/63517e4423a08de988256576006a80bc/fe15f75d7135a7e28825657e00710928!OpenDocument	Competitive generation. Regulated wires. http://www.eia.doe.gov/cneaf/electricity/page/fact_sheets/mass.html	Competitive generation. Regulated wires. http://www.nyserda.org/sep/sepsection2-1.pdf
Political and Administrative Actors	Environmental advocacy in the past and desire to avoid another energy capacity crisis. Energy efficiency focuses on electricity. http://www.energy.ca.gov/2005publications/CEC-999-2005-015/CEC-999-2005-015.PDF http://www.energy.ca.gov/2005publications/CEC-999-2005-011/CEC-999-2005-011.PDF http://www.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/49757.htm http://www.cpuc.ca.gov/static/energy/electric/energy+efficiency/about.htm	Strong environmental commitment and desire to reduce susceptibility to market risks. http://www.nwenergy.org/news/news/news_conservation.html	DSM instituted as an alternative to new plant construction in the late 1980s and early 1990s (integrated resource management). Energy efficiency now under the oversight of Division of Energy Resources. http://www.mass.gov/Eoca/docs/doer/pub_info/ee-long.pdf	PSC established policy goals to promote competitive energy efficiency service and provide direct benefits to the people of New York. On 1/16/06, Governor George E. Pataki unveiled "a comprehensive, multi-faceted plan that will help reduce New York's dependence on imported energy." http://www.getenergysmart.org/AboutNYES.asp http://www.ny.gov/governor/press/06/0116062.html
Demand-Side Management (DSM) Funding	System benefits charge (SBC) and procurement payment. http://www.cpuc.ca.gov/static/energy/electric/energy+efficiency/ee_funding.htm	SBC. http://www.wutc.wa.gov/webimage.nsf/8d712cfdd4796c8888256aaa007e94b4/0b2e39343c0be04a88256a3b007449fe!OpenDocument	SBC. http://www.mass.gov/Eoca/docs/doer/pub_info/ee-long.pdf	SBC. http://www.getenergysmart.org/AboutNYES.asp

Part of Washington's energy efficiency efforts can be explained by the high value for power exports to California, and partly by the regional focus on promoting energy efficiency. Washington and the rest of the Pacific Northwest region place a high social value on environmental protection, so Washington might be a case where the success of energy efficiency is fostered by high public awareness, and the willingness of the public to look beyond the short-term out-of-pocket costs and consider the longer term impacts on the environment.

The other three states shown in Table 5-3 share the common characteristics of high residential rates, energy efficiency funded through a system benefits surcharge, and competitive electric markets. The formation of competitive electric markets could have also encouraged energy efficiency by: (1) establishing secure funding sources or energy efficiency agencies to promote energy efficiency, (2) increasing awareness of energy issues and risks regarding future energy prices, and (3) the entrance of new energy agents promoting energy efficiency.

Key Findings

This chapter summarizes the challenges and opportunities for employing rate designs to encourage utility promotion and customer adoption of energy efficiency. Key findings of this chapter include:

- Rate design is a complex process that balances numerous regulatory and legislative goals. It is important to recognize the promotion of energy efficiency in the balancing of objectives.
- Rate design offers opportunities to encourage customers to invest in efficiency where they find it to be cost-effective, and to participate in new programs that provide innovative technologies (e.g., smart meters) to help customers control their energy costs.
- Utility rates that are designed to promote sales or maximize stable revenues tend to lower the incentive for customers to adopt energy efficiency.
- Rate forms like declining block rates, or rates with large fixed charges reduce the savings that customers can attain from adopting energy efficiency.
- Appropriate rate designs should consider the unique characteristics of each customer class. Some general rate design options by customer class are listed below.

— *Residential.* Inclining tier block rates. These rates can be quickly implemented for all residential and small commercial and industrial electric and gas customers. At a minimum, eliminate declining tier block rates. As metering costs decline, also explore dynamic rate options for residential customers.

— *Small Commercial.* Time of use rates. While these rates might not lead to much change in annual usage, the price signals can encourage customers to consume less energy when energy is the most expensive to produce, procure, and deliver.

— *Large Commercial and Industrial.* Two-part rates. These rates provide bill stability and can be established so that the change in consumption through adoption of energy efficiency is priced at marginal cost. The complexity in establishing historical baseline quantities might limit the application of two-part rates to the larger customers on the system.

— *All Customer Classes.* Seasonal price differentials. Higher prices during the higher cost peak season encourage customer conservation during the peak and can reduce peak load growth. For example, higher winter rates can encourage the purchase of more efficient space heating equipment.

- Energy efficiency can be promoted through non-tariff mechanisms that reach customers through their utility bill. Such mechanisms include:

— *Benefit Sharing Programs.* Benefit sharing programs can resolve situations where normal customer bill savings are smaller than the cost of energy efficiency programs.

— *On-Bill Financing.* Financing support can help customers overcome the upfront costs of efficiency devices.

— *Energy Efficiency Rebate Programs.* Programs that offer discounts to customers who reduce their energy consumption, such as the 20/20 rebate program in California, offer clear incentives to customers to focus on reducing their energy use.

- More effort is needed to communicate the benefits and opportunities for energy efficiency to customers, regulators, and utility decision-makers.

Recommendations and Options

The National Action Plan for Energy Efficiency Leadership Group offers the following recommendations as ways to overcome many of the barriers to energy efficiency in rate design, and provides a number of options for consideration by utilities, regulators, and stakeholders *(as presented in the Executive Summary):*

Recommendation: Modify ratemaking practices to promote energy efficiency investments. Rate design offers opportunities to encourage customers to invest in efficiency where they find it to be cost-effective, and to participate in new programs that bring them innovative technologies (e.g., smart meters) to help them control their energy costs.

Options to Consider:

- Including the impact on adoption of energy efficiency as one of the goals of retail rate design, recognizing that it must be balanced with other objectives.

- Eliminating rate designs that discourage energy efficiency by not increasing costs as customers consume more electricity or natural gas.

- Adopting rate designs that encourage energy efficiency, considering the unique characteristics of each customer class, and including partnering tariffs with other mechanisms that encourage energy efficiency, such as benefit sharing programs and on-bill financing.

Recommendation: Broadly communicate the benefits of, and opportunities for, energy efficiency. Experience shows that energy efficiency programs help customers save money and contribute to lower cost energy systems. But these impacts are not fully documented nor recognized by customers, utilities, regulators and policymakers. More effort is needed to establish the business case for energy efficiency for all decision-makers, and to show how a well-designed approach to energy efficiency can benefit customers, utilities, and society by (1) reducing customers bills over time, (2) fostering financially healthy utilities (return on equity [ROE], earnings per share, debt coverage ratios unaffected), and (3) contributing to positive societal net benefits overall. Effort is also necessary to educate key stakeholders that, although energy efficiency can be an important low-cost resource to integrate into the energy mix, it does require funding just as a new power plant requires funding. Further, education is necessary on the impact that energy efficiency programs can have in concert with other energy efficiency policies such as building codes, appliance standards, and tax incentives.

Option to Consider:

- Communicating on the role of energy efficiency in lowering customer energy bills and system costs and risks over time.

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